B. Specification

Please amend the paragraphs at page 1, line 18, through page 2, line 14, as follows:

--A CVD apparatus, an etcher, an asher, a surface modification apparatus, etc., have been known as microwave plasma processing apparatuses that [[uses]] use microwaves [[for]] as a plasma generating excitation source. In processing an object, this microwave plasma processing apparatus typically introduces a process gas in a process chamber[[,]] and supplies the microwaves from an external microwave supply unit into the process chamber through a dielectric window to generate plasma in the process chamber for excitations, dissociations, and reactions of the gas, and a surface treatment [[to]] of the object in the process chamber. Japanese Patent Application Publication No. 3-1531, for example, has proposed a film formation process with a microwave processing apparatus.

However, when the microwave plasma processing apparatus forms an extremely thin film with, for example, a thickness of 2 nm or ~~smaller~~ less through a film formation or surface treatment, for example, in order to form a gate oxide film on a silicon substrate, the process time becomes so short, as 1 second or ~~shorter~~ less in comparison with the stable controllable time, e.g., 5 seconds, that the controllability over the thickness deteriorates.--

Please amend the paragraph at page 3, line 16, through page 4, line 4, as follows:

--The processing apparatus may arrange the exhaust mechanism at a side of the plasma generating region in that is partitioned by the conductance adjuster, and the gas

introducing part at a side of the object in the process chamber that is partitioned by the conductance adjuster. The gas introducing part may include a first gas inlet for introducing into the process chamber a process gas for the plasma treatment [[to]] of the object, and a second gas inlet for introducing an inert gas into the process chamber, and wherein the exhaust mechanism and the first gas inlet are arranged at a side of the plasma generating region in the process chamber that is partitioned by the conductance adjuster, and wherein the second gas inlet is located at a side of the object side in the process chamber that is partitioned divided by the conductance adjuster.--

Please amend the paragraph at page 4, lines 7-15, as follows:

--A processing method of another aspect according to the present invention that accommodates an object in a process chamber and introduces a gas containing oxygen into the process chamber to provide a plasma treatment to the object so as to form an oxide film having a thickness of 8 nm or smaller includes the steps of maintaining a concentration of active species on the object from 10^9 to 10^{11}, and conducting the plasma treatment for a process time longer than 5 seconds.--

Please amend the paragraphs at page 8, line 17, through page 10, line 5, as follows:

--The gas introducing part 105 directs the gas, as shown in FIG. 1, from the bottom to the top. As a result, the substrate 102 is located at an upper portion in the gas flow than a surface of the dielectric window 107 at a side of the process chamber 101, around which the plasma is generated, or a plasma generating region P. As a result, the gas

is supplied to the surface of the substrate 102 via the plasma generating region P that occurs near the dielectric window 107, and the gas-generated, active-species concentration on the substrate remarkably reduces to 10^9 to 10^{11} cm^{-3}, which is much lower than that in a configuration that arranges the gas introducing part near the element 106 in FIG. 1.

The CVD method can use a known gas to form a thin film on a substrate.

A material used to form Si-system semiconductor thin films, such as a-Si, poly-Si and SiC, needs to be a gas or a material that can be easily ~~turn to~~ converted into a gas at the room temperature and the ordinary pressure, and includes an inorganic silane group, such as SiH_4 and Si_2H_6, an organic silane group, such as tetraethylsilane (TES), tetramethylsilane (TMS), dimethylsilane (DMS), dimethyldifluorosilane (DMDFS) and dimethyldichlorosilane (DMDCS), and a silane halide group, such as SiF_4, Si_2F_6, Si_3F_8, $SiHF_3$, SiH_2F_2, $SiCl_4$, Si_2Cl_6, $SiHCl_3$, SiH_2Cl_2, SiH_3Cl and $SiCl_2F_2$. ~~Additional~~ An additional gas or a carrier gas that can be mixed and introduced with Si material gas includes H_2, He, Ne, Ar, Kr, Xe and Rn.

A material used to form Si-compound thin films, such as Si_3N_4 and SiO_2, needs to be a gas or a material that can be easily ~~turn to~~ converted into a gas at the room temperature and the ordinary pressure, and includes an inorganic silane group, such as SiH_4 and Si_2H_6, an organic silane group, such as tetraethoxysilane (TEOS), tetramethoxysilane (TMOS), octamethylcyclotetrasilane (OMCTS), dimethyldifluorosilane (DMDFS), dimethyldichlorosilane (DMDCS), and a silane halide group, such as SiF_4, Si_2F_6, Si_3F_8, $SiHF_3$, SiH_2F_2, $SiCl_4$, Si_2Cl_6, $SiHCl_3$, SiH_2Cl_2, SiH_3Cl and $SiCl_2F_2$. Simultaneously introduced nitrogen material gas or oxygen material gas includes N_2, NH_3, N_2H_4, hexamethyldisilazane (HMDS), O_2, O_3, H_2O, NO, N_2O, NO_2, etc.--

Please amend the paragraph at page 11, lines 6-12, as follows:

--A surface modification [[to]] of the substrate 102 can be performed using an [[use]] appropriate gas, for example, for oxidation and nitridation [[to]] of the substrate or a surface layer made of Si, Al, Ti, Zn and Ta, or for doping with B, As and P. The inventive film formation is applicable to a cleaning method, for example, for cleaning oxides, organic materials and heavy metals.--

Please amend the paragraphs at page 13, line 14, through page 15, line 24, as follows:

--When the slot-cum plane microwave supply unit 108 is, for example, a slot-cum non-terminal circle waveguide, it includes a cooling channel and a slot antenna. The slot antenna forms a surface standing wave through interference of surface waves on the surface of the dielectric window 107 at its vacuum side. The slot antenna is a metal disc having, for example, radial slots, circumferential slots, multiple concentric or spiral T-shaped slots, and four pairs of V-shaped slots. [[An]] A uniform treatment over the entire surface of the substrate 102 needs a supply of active species with good in-plane uniformity. The slot antenna arranges at least one slot, generates the plasma over a large area, and facilitates control over the plasma strength and uniformity.

A description will now be given of an operation of the processing apparatus 100. First, a vacuum pump (not shown) exhausts the plasma process chamber 101. Then, the gas introducing part 105 opens a valve (not shown) and introduces the process gas at a predetermined flow rate into the plasma process chamber 101 through the mass flow controller. Then, a pressure regulating valve is adjusted to maintain the plasma process

chamber 101 at a predetermined pressure. The microwave oscillator supplies the microwaves to the plasma process chamber 101 via the microwave supply unit 108 and the dielectric window 107[[,]] and generates the plasma in the plasma process chamber 101. Microwaves introduced into the microwave supply unit propagate with an in-tube wavelength longer than that in the free space[[,]] and are introduced into the plasma process chamber 101 via the dielectric window 107 through the slots, and transmit as a surface wave on the surface of the dielectric window 107. This surface wave interferes between adjacent slots[[,]] and forms a surface standing wave. The electric field of this surface standing wave generates high-density plasma. The plasma generating region P has the high electron density and allows the process gas to become effectively [[get]] excited, isolated, and reacted. The electric field localizes near the dielectric window 107 and the electron temperature rapidly lowers as a distance from the plasma generation part increases, lowering damages to the device. The active species in the plasma are transported to and near the substrate 102 through diffusion, etc., and reach the surface of the substrate 102. ~~Since the~~ The exhaust channel 106 is located closer to the plasma generating region P than the substrate 102, and the substrate 102 is arranged in an upper portion in the gas flow introduced by the gas introducing part 105 than plasma generating region P. As a result, the substrate 102's active-species concentration, e.g., oxygen radicals, can be maintained between 10^9 and 10^{11} cm^{-3}. Therefore, an extremely thin (e.g., gate oxide) film having, for example, a thickness of 2 nm or smaller, can be formed on the substrate 102 through a plasma treatment with a stable, controllable time, such as longer than 5 seconds.

[[A film]] Film formation properly selects [[use]] a gas and effectively forms various deposited films, such as insulated films, e.g., Si_3N_4, SiO_2, SiOF, Ta_2O_5, TiO_2, TiN, Al_2O_3, AlN and MgF_2, semiconductor films, e.g., a-Si, poly-Si, SiC and GaAs, metal films, e.g., Al, W, Mo, Ti and Ta.--

Please amend the paragraph at page 16, line 22, through page 17, line 6, as follows:

--This embodiment used a microwave plasma processing apparatus 100A shown in FIG. 2 as one example of the processing apparatus 100 to form an extremely thin gate oxide film for a semiconductor device. 108A is a slot-cum non-terminal circle waveguide for introducing the microwaves into the plasma processing chamber 101A through the dielectric window 107, and 109 is a quartz conductance control plate. Elements in FIG. 2 [[which]] that are the same as those in FIG. 1 are designated by the same reference numeral, and [[which]] those that are variations or specific examples of those in FIG. 1 are designated by the same reference numeral with a capital letter.--

Please amend the paragraph at page 17, lines 11-27, as follows:

--The slot-cum non-terminal circle waveguide 108A has a TE_{10} mode, a size of an internal wall section of 27 mm x 96 mm (with a guide wavelength of 158.8 mm) and a central diameter of the waveguide of 151.6 mm (one peripheral length is three times as long as the guide wavelength). The slot-cum non-terminal circle waveguide 108A is made of an aluminum alloy for a reduced propagation loss. The slot-cum non-terminal circle waveguide 108A forms slots on its H surface, which introduce the microwaves into the

plasma process chamber 101A. There are six radial rectangular slots at a central diameter of 151.6 mm and 60° intervals with a length of 40 mm and a width of 4 mm. The slot-cum non-terminal circle waveguide 108A is connected to a 4E tuner, a directional coupler, an isolator, and a microwave power source (not shown) having a frequency of 2.45 GHz in this order.--

Please amend the paragraph at page 20, lines 9-24, as follows:

--This embodiment used a microwave plasma processing apparatus 100B shown in FIG. 3 as one example of the processing apparatus 100 to form an extremely thin gate oxide film for a semiconductor device. The processing apparatus 100B has the gas introducing part that includes an inlet 105A that introduces process gas and inlet 105B that introduces inert gas, and arranges the inlet 105A and exhaust channel 106B at the side of the plasma generating region P in the plasma process chamber 101B that is divided by the conductance control plate 109, and the inlet 105B at the side of the substrate 102. Elements in FIG. 3 [[which]] that are the same as those in FIG. 2 are designated by the same reference numeral, and [[which]] those that are variations or specific examples of those in FIG. 1 are designated by the same reference numeral with a capital letter.--

Please amend the paragraph at page 22, line 20, through page 23, line 2, as follows:

--This embodiment used a microwave plasma processing apparatus 100C shown in FIG. 4 as one example of the processing apparatus 100 to form a capacitor-insulating tantalum oxide film for a semiconductor device. Here, 109A is an aluminum

conductance control plate, and 108B is a coaxial multi-slot antenna. Elements in FIG. 4 [[which]] that are the same as those in FIG. 2 are designated by the same reference numeral, and [[which]] those that are variations or specific examples of those in FIG. 1 are designated by the same reference numeral with a capital letter.--